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# ***JPRS Report***

## **China**

### ***SCIENCE AND TECHNOLOGY***

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# Science & Technology CHINA

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## CONTENTS

29 September 1989

### ADVANCED MATERIALS

Two-Dimensional Neutron Flux Calculation Codes for Fuel Assembly of LWR [Xie Zhongsheng et al.; HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] Jun 89] .....	1
Feasibility Evaluation of Domestic Production of Materials for RPV [Feng Decheng; HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING] Jun 89] .....	1
Economic Analysis Program for PWR Fuel Cycle [Liu Dingqin; HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING], Jun 89] .....	1
Some Problems in the Investigation of CHF for PWR Fuel Assemblies [Ye Shurong; HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING], Jun 89] .....	2
Preparation of Nuclear-Grade Strongly Basic Anion Exchange Resin in Hydroxide Form [Ke Weiqing; HE DONGLI GONGCHENG [NUCLEAR POWER ENGINEERING], Jun 89] .....	2

### COMPUTERS

Development, Applications of Systems Simulation .....	3
Domestic Overview [Wen Chuanyuan, et al; JISUANJI SHIJIE [CHINA COMPUTERWORLD], 14 Jun 89] .....	3
Domestic Aircraft Systems Simulation [Han Kuanqing, Sun Ruikun, et al.; JISUANJI SHIJIE [CHINA COMPUTERWORLD], 14 Jun 89] .....	7

### MICROELECTRONICS

Current Problems in Semiconductor Market, Long-Range Demand Forecast [Shi Dunli; DIANZI SHICHANG, 22 Jun 89] .....	9
---	---

### SUPERCONDUCTIVITY

Study on Preparation of High-T <sub>c</sub> Superconducting Phase for Bi-System [Chen Zhixue, et al.; GUISUANYAN XUEBAO, No 3, Jun 89] .....	11
---	----

### TELECOMMUNICATIONS R&D

Developments in Satellite Communications Reported .....	12
New Series of Satcom Receiving Antennas [Yu Liuzhong; ZHONGGUO DIANZI BAO, 23 Jun 89] .....	12
Nationwide Stations, DFH-3 Plans [Li Qiongrui; ZHONGGUO DIANZI BAO, 7 Jul 89] .....	12
New Mobile Satcom Station [Yu Guocai; ZHONGGUO DIANZI BAO, 18 Jul 89] .....	12
New Satcom Digital Multiplexing Equipment [Cao Wenxi; ZHONGGUO DIANZI BAO, 28 Jul 89] .....	13
Three Digital Microwave Trunklines Completed [Shu Songbai; ZHONGGUO DIANZI BAO, 18 Jul 89] ..	13
Large-Scale Expansion of Microwave, Fiber-Optic, Satellite Long-Haul Communications Networks [DIANZI SHICHANG, 10 Jul 89] .....	13
Microwave Power Tube Developed; Can Replace Export-Restricted Item [Yu Kui; DIANZI SHICHANG, 29 Jun 89] .....	14

### Two-Dimensional Neutron Flux Calculation Codes for Fuel Assembly of LWR

40090077a Chengdu HE DONGLI GONGCHENG  
[NUCLEAR POWER ENGINEERING] in Chinese Vol  
10 No 3, Jun 89 (manuscript received 4 Jan 89) pp 1-6, 12

[English abstract of article by Xie Zhongsheng [6200 0112 3932] and Yin Banghua [1438 6721 5478] of Xian Jiaotong University and Zhang Zongyao [4545 1350 5069] of the Southwest Center for Reactor Engineering Research & Design, Chengdu]

[Text] Two multigroup transport assembly codes for a light water reactor (LWR) are developed. The interior flux within a mesh is assumed to be linearly dependent on X and Y coordinates. At the mesh surfaces the linear space distribution and the quasi-2P1 and QP1 approximations for the anisotropic angular distribution are considered. A series of 2-D assembly benchmark problems for an LWR have been tested. The numerical results are in good agreement with those of  $S_N$ , discrete nodal transport, surface flux transport and collision probability methods. These codes can be successfully used in the design of an LWR assembly.

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### Feasibility Evaluation of Domestic Production of Materials for RPV

40090077b Chengdu HE DONGLI GONGCHENG  
[NUCLEAR POWER ENGINEERING] in Chinese Vol  
10 No 3, Jun 89 (manuscript received 17 Sep 88) pp 7-12

[English abstract of article by Feng Decheng [7458 1795 6134] of the Southwest Center for Reactor Engineering Research & Design, Chengdu]

[Text] The technology and properties of reactor pressure vessel (RPV) A508-3 steel forgings, produced for the first time in China, are briefly described. Through an analysis of production experience, experimental research, domestic conditions, and newly added equipment, it is shown that to realize domestic production of an RPV for a 600MW nuclear power plant is not only necessary, but also feasible.

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### Economic Analysis Program for PWR Fuel Cycle

40090077c Chengdu HE DONGLI GONGCHENG  
[NUCLEAR POWER ENGINEERING] in Chinese Vol  
10 No 3, Jun 89 (manuscript received 16 Jul 88) pp 18-23

[English abstract of article by Liu Dingqin [0491 1353 2953] of the Beijing Institute of Nuclear Engineering]

[Text] An economic analysis code used for the PWR [pressurized water reactor] fuel cycle is developed. This economic code includes 12 subroutines representing various processes for the entire PWR fuel cycle, and also indicates the influence of the fuel cost on the cost of electricity generation and the influence of individual processes on the sensitivity of the fuel cycle cost. If possible, the cost table for various materials and services will be shown later on.

### Some Problems in the Investigation of CHF for PWR Fuel Assemblies

40090077d Chengdu HE DONGLI GONGCHENG  
[NUCLEAR POWER ENGINEERING] in Chinese Vol  
10 No 3, Jun 89 (manuscript received 20 Jun 88) pp  
65-69

[English abstract of article by Ye Shurong [0673 2885 2837] of the Southwest Center for Reactor Engineering Research & Design, Chengdu]

[Text] The mechanism of the effect of spacer grid on critical heat flux (CHF) is analyzed. The CHF experimental results of several fuel-rod bundles with different spacer grids are described and compared with each other. The empirical correlations are consistent with the EPRI [Electric Power Research Institute] CHF correlation.

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### Preparation of Nuclear-Grade Strongly Basic Anion Exchange Resin in Hydroxide Form

40090077e Chengdu HE DONGLI GONGCHENG  
[NUCLEAR POWER ENGINEERING] in Chinese Vol  
10 No 3, Jun 89 (manuscript received 4 Aug 88) pp  
84-87

[English abstract of article by Ke Weiqing [2688 0251 0615] of Qinghua University]

[Text] The two-step transformation method was used to prepare 90 kg of nuclear-grade strongly basic anion exchange resin by using the industrial-grade baking soda and caustic soda manufactured by mercury-cathode electrolysis. The chloride and bicarbonate fractions in the resin are 0.8 percent and 1.25 percent, respectively. The baking soda and caustic soda consumption is 8.6 and 13.7 times, respectively, the total exchange capacity of the strongly basic resin.

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## Development, Applications of Systems Simulation

### Domestic Overview

40080209b Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 23, 14 Jun 89 pp 34, 36

[Article by Wen Chuanyuan [2429 0278 3293], Wang Zhengzhong [3769 2973 0022], Xiong Guangleng [3574 0342 2807], and Li Bohu [2621 0130 5706]: "The Growth and Application of Systems Simulation in China"]

[Text] Editor's note: systems simulation is both a comprehensive technology discipline and also an important aspect of the application of computer technology. In sectors of China's aviation, space, military, scientific research, chemical, and power industries, it is being more widely applied, and has already generated excellent economic and social results. To enable our readers to have some understanding of the characteristics, situation, and developmental trends of this discipline, we have invited pertinent specialists from the China Systems Simulation Society to write the following group of articles in your behalf. The publication of this group of articles may also count as support and response to the "International Academic Conference on Systems Simulation and Scientific Solutions" to be held this year in China.

### I. The Thirty-Odd-Year Historical Process

Systems simulation is a rising new technical discipline, and at the same time it is a comprehensive testing discipline. Based upon similarity theory, control theory, and computer technology, it has gained wide application over the past 30 years because of its economy, safety, and special behavior. When it comes to complex research projects and the development of complex products, the first step is to undertake simulation of the plan verification, analysis, and design aspects, from which follows integration of research, manufacturing, and testing to make the simulation realistic. This is what is current and consistent about systems simulation in the research and production processes.

Use of simulation techniques can shorten development cycles and reduce development expenses, for which reason the Commission of Science, Technology, and Industry for National Defense has determined that no product may be finalized that has not undergone simulated testing. When simulation is used for training, it can have enormous economic and social results, and training simulators are used not only in aviation, space, and the military, but have also been widely used in the chemical industry and electric power sectors. Neither can the development of high technology be done without simulation, as for example with the CIMS (Computer Integrated Manufacturing Systems) in China's Project 863, where simulation technology will be a key technology in its implementation.

Because of the growth and widespread applications of the systems simulation discipline, in 1956 the International Analog Computer Association was founded, which changed its name in 1976 to the International Association for Mathematics and Computers in Simulation (IMACS) and is a sister organization to the International Federation on Automatic Control. Every three years this organization holds a large convention, broadly extending contacts among international systems-simulation societies.

The use of simulation technologies began in China not long after liberation, and in 1957 the first analog computer was developed; in 1958 the Beijing Aeronautical Engineering Institute used a LINC [laboratory instrument computer] in simulated testing of remote control, telemetry, and automatic control of the Beijing No 5 remotely piloted vehicle (RPV). After the Systems Simulation Professional Commission was founded in 1979 by the [China] Automation Society, the development of domestic systems simulation technology was integrated, and we began a series of exchange activities. From 1979 to 1988, we held six nationwide simulation academic conferences, which had more than 1,100 participants and resulted in the presentation of more than 740 papers over the six conferences.

In addition, we also held two monograph academic conferences: on digital simulation and control systems CAD (October 1982) and on training simulators (November 1984). And we held three classes: on systems simulation technology, simulation languages and control systems CAD, and control systems CAD and corresponding software packages, and began publication of XITONG FANGZHEN ZAZHI [SYSTEMS SIMULATION JOURNAL] in 1985 (semi-annual).

In 1985, the Systems Simulation Professional Commission joined IMACS as a scientific delegation member, and in 1984 and 1986 signed memoranda of cooperation with the American SCS [Society for Computer Simulation] transnational association and the Japanese simulation society JSST, respectively. We have had many articles presented at international conferences. At our instigation, IMACS, SCS, JSST, ASIM [expansion unknown], DBSS [expansion unknown], ISCS [International Society of Communications of Specialists], SIMS [expansion unknown], and UKSC [expansion unknown] are participating in jointly sponsoring the Beijing International Systems Simulation and Scientific Solutions Conference to be held in 1989 in Beijing.

The initiation of academic activities and the growth of science and technology are intimately related. The successful development of such complex simulation equipment as China's fighter flight simulator (developed by units at the Beijing Aeronautical Engineering Institute, Shuguang Electric Machinery Plant, and the Precision Machinery Institute, it won a national first prize for scientific advances), power-plant training simulator (developed by Qinghua University), the Galaxy digital simulation computer (developed by the University of

Science & Technology for National Defense and other units), and the Navy tactical simulator (developed by Qinghua University and other units), all placed into actual use, are all indications of the remarkable growth of China's simulation technology and equipment.

To meet the needs for the growth of systems simulation science and simulation systems technology, with the permission of the State Science and Technology Commission, the China Systems Simulation Society was officially established on 12 February 1989, when it convened its first board of directors.

## II. The Systems Simulation Discipline and Its Fundamental Theory

The systems simulation discipline still has no clear definition, and what constitutes the special fundamental theories of the systems simulation discipline cannot be defined; this will hinder the further intensification and growth of the systems simulation discipline.

The origin of the phrase was in the document "An Exploration of Similarity Theory," by which was intended the systems simulation discipline and similarity theory and in which appeared the following description: "When people are cognizant of the objective world, their receptors are receiving information and changes therein, and through the conformity of transformed units and all levels of neural structures, the intermediate results obtained at each level are all similar, and the final result is naturally similar, which means that it cannot be completely identical with the objective world. At the same time, when people are analyzing and solving problems, they first gather and arrange information pertinent to the problem, making use of existing experience and the cerebrum to analyze logical functions, to dissect and infer, and finally to produce decisions or conclusions. If information gathering is incomplete and somewhat false, if experience is lacking, if logical integration functions are insufficient, then after multi-level approximations, the eventual conclusions cannot generally be completely in keeping with the conclusions of objective rules. What is more, because of differences in people's backgrounds and physiological structures, the conclusions that individuals draw will not be entirely the same, and can even differ widely. We can see from this that similarity theory has universal significance. This is especially true for simulation systems, and whether mathematical models or the individual components of simulators, there will always be errors, and therefore results between levels and the final results can only be similar. This is why similarity theory has an important real significance for engineering and why such things as similarity modes, similarity methods, and degrees of similarity, among other things, are important tools for analysis and calculation similarity systems. For this reason, similarity theory is the special fundamental theory for the systems simulation discipline. We can

define the systems discipline in the following way: systems simulation is a comprehensive discipline and comprehensive testing discipline built upon a basis of similarity theory, control theory, and calculation technologies."

We believe that clarifying the definition of the systems simulation discipline and clarifying the fact that similarity theory is the special fundamental theory for the systems simulation discipline, together with deeper research, will undoubtedly prove vital for the growth of the systems simulation discipline.

## III. The Situation in China Regarding the Development of Simulation Computer Systems

From the point of view of accomplishing the simulation task, what interests us are digital computers and their system structures. This growth may be divided into five stages: where the CPU is the core, where storage devices are at the center; where main memory is central, and where also a bus structure is adopted; distributed multiple processors or multiple-computer systems; and computer networks. Analog computers and their development process are: analog computers; hybrid analog computers; hybrid computer systems made from analog computers and digital computers; and hybrid computer systems made from automatic problem-arranging [paiti] analog computers and digital computers.

The topology structures of contemporary local area computer networks may be generally divided into: the star structure, used in hierarchical master-slave networks and using centralized control, such as DEC-Net; the ring structure, without centralized control and where no station has a master-slave relation, with one-way transmission, and good real-time performance, as for example with the American Apollo's Company's Domain network; bus structures, suited to dispersed control, as for example with Ethernet; tree structures; and various hybrid structures between various elements. As far as the problem of synchronization of multi-computer systems is concerned, that synchronization is usually done through a central clock, or a distributed clock, or cyclic token-passing (token-passing has certain privileges).

As far as simulation computers or relevant computer systems are concerned, aside from such analog computers or systems as the NADAC100 and HYSHARE700, and such digital computers as the VAX 11/780, that China has imported, we began in 1958 to develop relevant simulation computer systems.

For example, during the period 1958-65 the Beijing Aeronautical Engineering Institute, the Tianjin Electronic Instruments Plant, Beijing Radio Plant No 1, the Chinese Academy of Sciences' (CAS) Institute of Automation, and Institute No 2 of the Ministry of Astronautics Industry all developed analog computers. Among them, the J3 31 mainframe analog computer of the CAS Institute of Automation won a national major research achievements award (1965); and the M2 developed by Institute No 2 of the Ministry of Astronautics Industry



won an award at the national conference on science and technology (1978). In 1965, China began development of the second generation of simulation computers. Representative among them were the M6 hybrid analog computer developed by Institute No 2 of the Ministry of Astronautics Industry (which won an award from the national conference on science and technology), the HMJ-200 hybrid analog computer developed by the Beijing Radio Plant No 1, and the HAP2/DJS130 hybrid computer system developed by Institute No 502 of the Ministry of Astronautics Industry (which won a third prize for national defense research). In 1980, China entered the third generation of simulation computer development, among which products was the Galaxy Simulation Computer YF-1 developed by the University of Science & Technology for National Defense; in 1985 this computer won a first prize for national technological advances.

The Naval Tactical Training Simulation System developed in 1986 by Qinghua University uses a multi-computer system structure, and it is now in use by the Navy. An integrated, dispersed-control, fiber-optic-bus, distributed computer system developed by Beijing Aeronautical Engineering Institute is now in use for teaching and research.

Due to the importance of distributed processing computer systems and their bright future, in 1987 we held our Sixth All-China Systems Simulation Conference (that is, the Parallel Processing and Distributed Processing Computer Systems Monograph Conference). Fifty-nine papers were presented at the conference—papers on distributed processing system software, structure, algorithms, and particular systems—and experiences were exchanged regarding distributed processing systems, which helped to promote advances in research and production in this field.

It is worth pointing out that during the 1980s there have appeared specialized multi-processor computer systems oriented toward simulation, as well as vector computers of relatively low price. These systems have supercomputer capabilities, but their prices are only 10-20 percent of that kind of computer. These are called minisupercomputers, and they mostly use the MIMD (multiple instruction stream/multiple datastream) system structure. During the Seventh 5-Year Plan, China has also included development of this kind of computer in implementation planning. For example, there is the research effort on the minisupercomputer that is being done by the University of S&T for National Defense and by Institute No 2 of the Ministry of Astronautics Industry.

#### **IV. The Situation Regarding Development of Simulation Software**

Simulation software includes: simulation program packages, simulation languages, and simulation environments.

Among the functions included in simulation program packages are: the execution and control of simulated

testing; the analysis, display, and file storage of data and results; and one or two functions out of the following three: the storage, retrieval, and management of patterns, test formulae, data, graphics, or knowledge.

Simulation languages have the following three functions: pattern-description rules and processing; the execution and control of simulation testing; and the analysis, display, and file storage of data and results.

Among functions that belong to the simulation environment of simulation software categories: aside from having the three functions of simulation languages mentioned above, they also have storage, retrieval, and management functions for patterns, test formulae, data, graphics, or knowledge. Therefore, simulation environments are unified software systems that have all four functions.

The simulation software that has just been described is all simulation software used in digital simulation. Digital simulation languages that make up the bulk of digital simulation software may be divided into three categories: the Continuous System Simulation Language (CSSL), suitable for the mathematical modeling of ordinary differential equations, partial differential equations, and difference equations; the Discrete Event Systems Simulation Language, suitable for use in the mathematical modeling of process interaction, event handling, or activity description; and the Continuous/Discrete Combined Systems Simulation Language, which combines the first two languages.

Simulation software for the hybrid computer systems includes: HYTRAN and OHI, types of hybrid connection and operating software, in development since about 1968; ECSSL, the analog program automatic design software developed in 1976; and HYSHARE, the hybrid operating system with time-sharing functions that was developed in 1978.

From the point of view of the development process for digital simulation software, since 1955, when the first digital simulation software was announced, the process has gone through five stages. The development goals have been to constantly improve the problem- and user-oriented model-description capabilities, together with its functions in the areas of model building, test analysis, design, and verification.

The first phase was the general-purpose program design language stage, as for example with FORTRAN from about 1960, up through contemporary general-purpose program design languages, as well as such languages as Ada and C++, which have concurrent process functions and are still being widely used in simulation fields.

The second phase was the initial simulation language stage, as for example with the flowchart-oriented MIDAS of the 1960-70 period, and CSSL, the equation-oriented continuous systems simulation language.

The third phase (1970-80): the stage of high-level simulation languages. Characteristics of high-level simulation languages include being closer to perfection and up to a commercial standard, as for example the continuous systems simulation languages CSSL IV, CSMP II, DAREP and ACSL. There are also the discrete-event systems simulation languages like GPSS IV, SIMSCRIPT III, and SLAM.

The fourth phase (1984-): an integration of model building with simulation environment software, as with TESS, released by the American Pritsker Company in 1984. This is an integrated software system comprising eight parts: it can store and retrieve data through databases, and does scenario simulation/data collection, data analysis, reporting and graphics generation, scenario drawing, network model input, run control, and data management.

The fifth phase (the latter 1980s): intelligent environmental model-building and simulation environmental software, which is composed of integrated environmental software, expert systems, and intelligent interfaces; it manages such things as model libraries, method libraries, test formulae libraries, databases, and knowledge bases. And it can make full use of existing languages such as FORTRAN, C, Ada, and LISP.

In the field of simulation languages, at the same time as China has imported computers we have also brought in some simulation software, on which we have done much revision, expansion, and porting. These efforts have been turned to our own designs, as for example with ICSL, a continuous systems simulation language (which also won a first prize for scientific advances from the Ministry of Astronautics Industry). Integrated simulation software developed during the Seventh 5-Year Plan has been incorporated into planning.

Regarding computer-aided design (CAD) programs, there are many units currently broadly beginning work in this area. Especially worthy of mention is the CCSCAD software package developed jointly by more than ten units of China, which is a control-systems CAD software package that is the largest and most complete of its kind in China. This software officially passed its evaluation in 1986, when it was deemed to have met international standards.

Since the founding in 1979 of the Simulation Profession Commission, many papers have been published on the subject of software. Their topics have included various simulation programs on hybrid computers and digital computers, simulation languages, and integrated model-building with simulation environments. In recent years, many papers have also been published on peripheral array machines and multi-processor simulation software.

#### **V. The Integration of Simulation With Artificial Intelligence**

In 1943 W.S. McCulloch and W.H. Pitts proposed the neural network mathematical model to explore cerebral

functioning, and this can be seen as the beginning of research into artificial intelligence. After this, research was begun on artificial intelligence in the two areas: the simulation of human brain physiological structure and the simulation of human brain functions (cognition methods); while the former has not progressed much, the latter has developed quickly in the area of research on expert systems, and it has gradually expanded its application field. In 1969, researchers at Stanford University in America developed the DENDRAL expert system to use raw data for matching to determine the chemical structure of certain substances, that is, their type. Academic activity in expert systems has been getting more and more lively in recent years both in China and abroad. For example, at the Expert Systems Monograph Conference held in Barcelona [?] 2-4 July 1987 by IMACS, topics included: artificial intelligence technology and tools for control and robots; things related to knowledge-based model-building environments; intelligent simulation environments; the application of AI techniques to manufacturing systems for description and simulation; model-building and simulation expert systems; expert systems and numerical methods for electrical engineering; various types of knowledge representation for intelligent model-building and simulation; expert systems for civil and forestry engineering; intelligent simulation systems; intelligent systems for partial-differential-equation simulation; and intelligent simulation languages and environments. The integration of artificial intelligence with simulation enables simulation technology to reach a new height, and has become a topic in the forefront of contemporary simulation field research. Simulation circles in China recognized this problem early on, and have published research papers on the subject. In 1986 and 1987, some simulation expert systems were developed in China, and these have begun to move toward the operational stage.

#### **VI. Development of Simulators in China**

Simulators are comprehensive uses of simulation computer systems, simulation software, expert systems, and other relevant technologies, and they have become important tools for the research, design, training, and testing of complex systems. In the area of developing simulators, we in China have made constant progress and achievements. Besides the fighter flight simulators, power-plant simulator, and naval tactical simulator already mentioned, there have been many other outstanding accomplishments. These include the large-scale combat training simulator developed by the Operational Research Institute of the Academy of Military Sciences, the Surface Ship Integrated Training Simulation System developed by the Dalian Warship Institute, and the F-7II Aircraft 6-degrees-of-freedom Flight Simulator developed by the Air Force Military Training Equipment Plant (this simulator is outfitted with handy digital computer imaging devices developed by the Beijing Aeronautical Engineering Institute).



### Domestic Aircraft Systems Simulation

40080209b Beijing JISUANJI SHIJIE [CHINA  
COMPUTERWORLD] in Chinese No 23, 14 Jun 89 pp  
50-52

[Article by Han Kuanqing [7281 1401 1987], Sun Ruikun [1327 3843 0981] and You Chonglin [3266 1504 2651]: "The Application and Development of Aviation Systems Simulation"]

[Excerpt] [Passage omitted]

It should be said that another important development in flight simulators is the progressive improvement in standards and norms. Beginning in the 1950s, the Americans have worked out norms or standards for trainers, cockpit program trainers, trainer software, motion systems, and the corresponding military technical requirements. Also, based on the requirements of technical developments, they have regularly supplemented, revised, and perfected these standards. At present, use of flight simulators in such Western developed countries as the United States is just like getting approval for an aircraft: they must be approved and licensed by the U.S. Federal Aviation Administration (FAA). What the FAA uses for its acceptance are just the standards and norms we have been discussing. According to the requirements for different grades of civilian aircraft flight simulators as they have been formulated by the U.S. FAA, there are no fewer than 10 Grade III (the highest level) flight simulators throughout the world, and the MD-82 flight simulator at the Shanghai Civilian Aviation Training Center is one of them.

### III. Rapid Development of Object Simulation

China's aviation systems simulation efforts began during the 1950s. Aside from some simple aimed-fire, instrument flying, and bombing simulators, at that time engineering was primarily involved with the simulation of control systems, and electronic simulation computers on three-axis revolving platforms were used for closed-loop research. Because the performance of the revolving platforms greatly influenced the accuracy of the simulation, beginning in the 1950s, the former Ministry of Aviation Industry system jointly arranged for problem solving, and gradually formed a contingent of experts for the design and production of revolving platforms. The platforms they produced saw much use in systems simulation during the 1970s. In the latter part of the 1950s, because of longitudinal vibration in domestically produced fighter aircraft, which affected the production plants, the relevant plants and institutes all set up control-system test platforms as needed for their own efforts. At the same time, they used electronic analog computers to simulate the dynamic states of the aircraft. To this they added simple flight instruments to constitute closed-loop complete aircraft simulation systems, which were the earliest hardware-in-loop simulation facilities in China. During the 1960s and 1970s, much use was made of these, as for example with the SB-6 [flight] control-system simulation test platform from Institute No 630. During the period from 1965 through 1980, eight different machines were completed, more than 20 control

systems, and simulation testing and research of more than 50 different rudders. In the 1970s, because of a quick rise in the demands made by rapid growth in aviation technology on simulation, the aviation system in China also entered a new age. The specific indications are: there is beginning to be a conversion to digital computers for simulating aircraft dynamic states; cockpits are configured with 3- or 6-axis motion systems; scene-viewing systems have developed from point light sources and closed-circuit television to computer imaging systems; control sensation systems have also developed from simple springs to computer-controlled electrohydraulic servosystems, which has enabled the friction of the cylinder to be reduced nearly to 0, improving the realism of the insertion-force simulation. The vast majority of aviation institutes are now equipped with advanced VAX computers, and they have begun a great deal of work in pure mathematical simulation and hardware-in-loop simulation.

In the area of training-flight simulators, during the early 1970s the civilian airline imported Boeing 707 and Trident flight simulators. To promote the aviation simulation effort in China, in 1983 the former Ministry of Aviation Industry developed the first large-scale flight simulator in China—the F-6 flight simulator, which achievement won a national-level first prize for S&T advances. On the basis of these achievements, we have developed over the past few years a load-control system that is highly realistic and variable, a 6-axis motion system, and a computer-imaging scene-viewing [shijing] system, all of which are being applied to the newly developed aircraft flight simulators.

### IV. Some Recommendations

In a review of the 60-year world history of the development of aviation systems simulation and of our 30-year history, it is not difficult to discover that aviation systems simulation has made pleasing progress toward stimulating the growth of aviation, and that it has an extremely bright future.

In comparing China's aviation systems simulation with advanced world standards, there is still a significant gap. If we are to reduce this gap as quickly as possible, it is our belief that attention should be paid to the growth of the following technical fields.

The first is simulation theory and methods. Simulation is experimental research that approaches reality, and it has its own characteristics, theory, and methods. The value of simulation lies in establishing believability. Training flight simulators that are lacking in reality can lead to serious problems with flight safety. Engineering flight simulators that are less than realistic cannot generate accurate analytical and design data, and it is therefore difficult to come up with accurate design schemes. To resolve the problem with the believability of flight simulators, it is imperative to formulate technical performance norms and standards for the entire flight simulator and for each subsystem. At present, in order to enhance the fidelity of flight simulators during the simulation process, it is necessary to make more

efforts to develop real-time automatic verification software and automatically optimized programs.

Then, we must concentrate our efforts on accelerating the development of general-purpose engineering applications software systems. Aircraft dynamic-state models and data should be uniform and general-purpose, by which means we can avoid repetitive model-building and model-testing efforts, and also by which we can enable simulation in all application areas to have the same basis for believability. To promote the development of these efforts, pertinent plants, institutes, and academic institutions should initiate the necessary preliminary research.

Third, we should begin research on some key technologies as soon as possible, and these include real-time image generation and display systems, six-degrees-of-freedom coordinated motion systems, and load-control systems. The quality of these systems directly affects the performance of flight simulators.

Fourth, we should enhance research on developmental trends for aviation and aerospace technology and tactical environments for the 1990s and around 2000. With this research as a basis, the development of flight simulation technologies will be able to meet future demands, and can keep pace with the growth of aviation.

### **Current Problems in Semiconductor Market, Long-Range Demand Forecast**

40080217 Beijing DIANZI SHICHANG  
[ELECTRONICS MARKET] in Chinese 22 Jun 89 p 2

[Article by Shi Dunli [4258 2415 4409]: "Current Problems and Demand Forecast of China's Semiconductor Market"]

[Text]

#### **Current Problems in China's Semiconductor Market**

China's semiconductor industry has taken a circuitous development path and has long overemphasized catching up in sample technology while neglecting production and market requirements, so that research has been seriously out of touch with production, which in turn has been out of touch with the market. As a consequence, no effort has been made on certain product technologies that are genuinely needed by the market; production costs have not been brought down; quality is inadequate; full ranges of devices are not available, even in the case of medium-scale [MSI] and small-scale [SSI] integration; and there are not sufficient supplies of such color television components as high-current diodes, high-voltage power transistors and the like to meet domestic market demand. In addition, the semiconductor industry has not yet established itself economically in China, and its performance-to-cost ratio is low, preventing it from engaging in international market competition. As a result, China's semiconductor market is plagued by inadequate supplies and is being buffeted by imports.

In 1984-1986, China's [annual] output of IC's hovered between 40 and 50 million units, but annual sales on China's IC market during these 3 years were 119.4 million, 172.1 million, and 230.8 million units. Chinese-produced circuits failed to meet user requirements in terms of quantity, assortment, quality, and price, so that available stocks could not be fully sold, further decreasing the industry's ability to engage in international competition.

In addition, owing to the above factors, China's IC products are quite unable to satisfy the needs of domestic economic development or meet electronic equipment requirements; furthermore, in the course of reform and opening up, no timely limitation and protection policy for the IC market has been issued, and this fact, coupled with oversights in management, has enabled circuits imported through a variety of channels to strike a serious blow at China's semiconductor market.

Available statistics indicate that imported IC's account for more than half China's IC market. But it should be noted that the statistical data on imported circuits consist only of the numbers furnished from the former China Electronic Components Company and the Microelectronics Office of the Ministry of the Electronics

Industry and do not yet include nongovernmental imports of circuits; as a result, the actual importation of IC's is greater than the above figures.

#### **Prediction of China's Semiconductor Market Structure and Requirements**

In the last 1 or 2 years, the relevant departments have begun to adjust the development of China's semiconductor industry in order to orient it toward the market and make it satisfy the needs of the various sectors of the economy, of consumer electronics and of military devices. The semiconductor market is switching from an overemphasis on the catch-up model to a commodity-oriented market model; production is changing over from the workshop type to intensive large-scale production; in product structure, the focus on general-purpose IC's is being replaced by a development strategy based on application-specific IC's; and there has been increased emphasis on review of IC imports, with specific organizations designated for the purpose. As a result, starting in 1987, China's IC's took a turn for the better, with output reaching 76.764 million units, breaking through the 50-million-unit barrier at which it had long hesitated, and the IC market is beginning to approach a balance between output and sales. For example, in the first 9 months of 1987, the Wuxi No 742 Plant produced 20.77 million IC's and sold 19.0 million, or 91.5 percent of its output. During this period Shanghai produced 9.47 million IC's and sold 8.78 million, or 92.7 percent.

At present, China's IC market structure is focused primarily on consumer IC's, but there are large fluctuations: in the 3 years from 1984 to 1986, consumer electronics products accounted for 71.9, 52.9, and 61.8 percent of all IC's; it is predicted that in 1990 consumer electronics will still account for 39.6 percent of the IC market.

There are currently two domestic predictions of China's future IC market. According to one, in 1990 the market demand will be 400-600 million units, and that with average increase in output of 23 percent per year, China's IC market demand will be 1.1 billion units in 1995, 3.2 billion in the year 2000, and 9.0 billion in 2005; by 2005 China's IC market demand will be equal to the IC output of the United States in 1982. The other prediction is that, based on the overall market requirement for IC's and the rate of growth of the electronics industry, by 1995 China's IC market demand will be 1.1 billion units, of which 41 percent (656 million units) will be for consumer products, 25 percent (400 million units) will be computer IC's, 15 percent (240 million units) will be communications IC's, 10 percent (160 million units) will be used for automated control and instrumentation, and the other 144 million units will be for military use and maintenance purposes.

The VLSI's of the future are devices that will—on a single chip—incorporate information acquisition (sensor

circuits), communications processing and control (computer and control circuits), and high-power-output functions (new types of power components and high-voltage power IC's). High-voltage power devices are key components of switched power supplies, AC-DC converters, highly energy-efficient lights, technologically modernized machine tools, and integrated electromechanical devices; they have very extensive uses in energy conservation, electricity conservation, civilian televisions, VCR's, radio-tape recorders, electronic instruments, motor control, power control, long-distance communications (repeaters) and the like. As a result, the development, production and application of such devices is receiving great attention abroad.

Recently, party and state leaders Comrades Li Ximing and Song Jian attached major importance to developing semiconductor power devices and have given major

instructions on the subject. Domestic experts predict that in 1990-1995 the domestic market demand for power IC's such as VMOS [vertical metal oxide semiconductor] transistors will be: 3-5 million units per year for broadcast communications, 8-10 million units per year for electromechanically integrated equipment, 2-2.5 million units per year for computers, 400-500 thousand units per year for military purposes, 12-15 million units per year for current and voltage converters, and 20-25 million units per year for consumer electronics, making a total of 45.4-58 million units per year. On the international market, it is estimated that sales will be 713-745 million yuan per year, with profits of 123-137 million yuan per year.

As a result, a high priority should be attached to developing power semiconductors and power IC's.

**Study on Preparation of High- $T_c$  Superconducting Phase for Bi-System**

40090075 Beijing GUI SU ANYAN XUE BAO  
[JOURNAL OF THE CHINESE CERAMIC SOCIETY] in Chinese Vol 17 No 3, Jun 89 (manuscript received 10 Dec 88) pp 284-288

[English abstract of article by Chen Zhixue [7115 1807 1331] and Ji Xiaoyang [0679 2556 3152] of Central Laboratory, Sichuan University]

[Text] A sample of  $\text{Bi}_2\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_y$  superconductor with zero resistance at 109K and diamagnetism transition onset temperature of 108K has been prepared by means of solid-state reaction in a mixture of  $\text{Bi}_2\text{O}_3$ ,  $\text{SrCO}_3$ , and  $\text{CaCO}_3$  and  $\text{CuO}$ . The mixture was calcinated at 800°C in air for 15 hours, then powdered and cold-pressed into pellets at a pressure of 4 MPa [megapascals]. The pellets were sintered at 890°C in air for 14 hours. By reducing the furnace temperature to 400°C, samples were taken out from the furnace.

$\text{Bi}_{2-x}\text{Pb}_x\text{Sr}_2\text{Ca}_2\text{Cu}_3\text{O}_y$  ( $x = 0.2-0.8$ ) superconductors have been successfully synthesized by solid-state reaction. The ceramic samples were sintered at 860°C in air for 68 hours. The formation of ceramic phase under the above two different sintering conditions is discussed.

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## Developments in Satellite Communications Reported

### New Series of Satcom Receiving Antennas

40080227 Beijing ZHONGGUO DIANZI BAO in Chinese 23 Jun 89 p 3

[Article by Yu Liuzhong [0151 0362 0022]]

[Text] In late May, a new series of satellite communications earth-station antenna systems (with aperture sizes of 6-m, 7.3-m and 12-m) developed by the No. 39 Research Institute of the Ministry of Machine-Building and Electronics Industry passed technical certification. These antenna systems provide an effective solution to the difficult problem of achieving dual circularly-polarized frequency multiplexing; they also satisfy the new broad-sidelobe requirement with 2-degree satellite separation. In particular, the technical performance of the antennas in terms of circularly polarized axial ratio, terminal separation and tracking accuracy exceed the original specifications established by the State Council's former Leading Group for Development of Electronics Industry. The structure of the antennas is designed to achieve high reliability and to facilitate installation and adjustment. The certification committee believed that the antenna performance meets the technical specifications established for Intelsat receiving stations (IESS-1985 standards), and is comparable to the state-of-the-art performance.

In addition to the series of satcom receiving antennas, this institute has also developed China's first large-aperture antenna system for a multi-band radio telescope as well as antennas of various aperture sizes (0.75-m, 1.0-m, 1.2-m, 1.8-m, 2.6-m, 3.0-m, 4.2-m, 5.0-m, 6.0-m) for television receive-only [TVRO] stations.

### Nationwide Stations, DFH-3 Plans

40080227 Beijing ZHONGGUO DIANZI BAO in Chinese 7 Jul 89 p 1

[Article by Li Qiongrui [2621 8825 3843]: "China's Satellite Communications In the Ascendant"]

[Text] During the "Dongfang Hong-3" (DFH-3) Satellite Users Conference sponsored by the State Science & Technology Commission on 27 June, this reporter learned that within a few short years, China's satellite communication and television industry, which provides the primary mode of modern information exchange, has made remarkable progress that has attracted worldwide attention. According to authoritative sources, today there are nearly 15,000 satellite ground stations and television receive-only [TVRO] stations in service, and 12 satellite transponders which are either leased from foreign satellites or provided by our own satellites; communications and television coverage over the Chinese territory has increased significantly.

China's communications satellite program began in 1984 with the successful launch of the first experimental communication satellite. In 1985, the program was further expanded with the construction and testing of 53 satellite TVRO ground stations. Today, the satellite TV broadcast network is carrying two sets of programs created by the Central Television Station and two sets of educational programs created by the National Education Commission to the four corners of this country including the Tian Shan mountain regions, the Tibet highlands, the Yunnan-Guizhou borders, and the Xisha Islands. In the area of communications, both voice and data communications, links have been established and tested. More than 30 stations connected by low-to-moderate-speed communications links around medium and small cities have become operational; high-speed data communication links are also under development or being imported.

A satellite communication system generally consists of two main segments: the ground station, which includes the transmitting and receiving systems, and the transponders onboard the satellite. Initially, China had 4.5 transponders which were leased or purchased from the Intelsat organization. Subsequently, with the successful launch of two DFH-2 communication satellites, the number of available transponders increased to 12. The DFH-3 satellite which is currently under development and expected to be launched in 2-3 years will have 24 transponders. By that time, China's satellite communications network will consist primarily of our own satellites supplemented by a limited amount of foreign equipment. According to a spokesman for the China Broadcast Satellite Company, which is responsible for the operation and management of China's communication satellites, after the launch of the DFH-3, China will have 30-40 transponders available for domestic users. In the future, the State will no longer provide free transponder service to the individual departments and organizations; instead it will be provided on a "compensated service" basis.

### New Mobile Satcom Station

40080227 Beijing ZHONGGUO DIANZI BAO in Chinese 18 Jul 89 p 1

[Article by Yu Guocai [0060 0948 2624]]

[Text] In order to satisfy the needs of China's national defense and economic development, a new mobile satellite communications station has been developed by the No. 54 Institute of the Ministry of Machine-Building and Electronics Industry Shijiazhuang. A few days ago, it passed acceptance test and was delivered to the users.

This mobile station was developed in response to a request by the Signal Corps Department of the PLA General Staff. It has two major segments: the electronics compartment and the container. All the electronic equipment is installed in a thermally insulated, electromagnetically shielded and air-conditioned electronics compartment which measures 2 m high, 2.2 m wide, and 4 m

long. It serves both as a shipping container and as an operating room. During shipping, it is stored inside the container; during operation, it can be set up on top of the container and ready for transmission within a few hours. Equipped with its own elevator, this mobile station has greater mobility and flexibility than conventional communications equipment carried by ground vehicles, ships, or aircraft. This station has 10 high-fidelity, digital secure voice channels (or conventional voice channels). It can directly interface with a manual switching unit and transmit teletype or cable messages; it also has multiple interfaces for functions such as satellite television broadcast and code-division I.F. transmission. A state-of-the-art microprocessor is used to monitor in real time the operations of every piece of equipment in the station and print out the time and location of any malfunction in Chinese language. Microprocessors are also used to control the antenna for automatic target acquisition and tracking, and to display the azimuth and elevation angles of the antenna.

The electronics compartment and container of this mobile station are used for the first time in domestic satellite communications; nonetheless, their electrical specifications, structural design and performance are considered to be comparable to the advanced standards of other communications, equipment used in this country. The station has also incorporated advanced technologies from abroad and used standardized, serialized and modularized components to provide interchangeability with components used in similar equipment from other countries. All of the equipment is domestically manufactured.

#### **New Satcom Digital Multiplexing Equipment**

40080227 Beijing ZHONGGUO DIANZI BAO in Chinese 28 Jul 89 p 1

[Article by Cao Wenxi [2580 2429 0823]]

[Text] During the first "Torch Cup" High-Tech Product Exhibition, the MCPC satcom digital multiplexing equipment developed jointly by the Changzhou Radio Factory and Qinghua University recently received an award certificate and plaque for superior product [quality] from the State Science & Technology Commission.

This high-performance, low-cost domestically made satellite communications equipment has for the first time in this country implemented spectral shaping techniques using a rising cosine roll-off filter; the transmitted spectrum meets the requirements of the Intelsat IDR [intermediate data rate] specifications. The unique features of this equipment are its versatile interface, simple operation, high degree of security and low cost. Currently, MCPC satcom digital multiplexing equipment has been installed at the ground stations in Guangzhou and Urumqi.

#### **Three Digital Microwave Trunklines Completed**

40080229 Beijing ZHONGGUO DIANZI BAO in Chinese 18 Jul 89 p 1

[Article by Shu Songbai [5289 2646 2762]: "Three Microwave Trunklines Completed in Yunnan, Anhui, and Sichuan"]

[Summary] In order that the masses in remote mountainous areas of Yunnan, Anhui, and Sichuan Provinces might receive programs broadcast by China Central Television, three digital microwave (DMW) communications trunklines were completed—one in each of the aforementioned provinces—between mid-May and mid-June. These three lines, installed by the Li Jiang [3347 3068] Radio Plant of Guilin, Guangxi, use DMW communications equipment manufactured by the plant and can transmit digital telephone, color TV, and stereo sound signals.

The Yunnan line runs from Kunming to Xishuangbanna, Wenshan, and Cangshan for a total straight-line distance of over 900 kilometers; the Anhui line runs from Hefei to Wuhu over a range of more than 300 kilometers; and the Sichuan line runs from Chengdu to Tongjiesi, a straight-line distance of over 200 kilometers. All technical performance indicators, as established by trial transmissions, have met requirements.

#### **Large-Scale Expansion of Microwave, Fiber-Optic, Satellite Long-Haul Communications Networks**

40080233b Beijing DIANZI SHICHANG [ELECTRONICS MARKET] in Chinese 10 Jul 89 p 1

[Unattributed article]

[Summary] In an effort to improve communications trunklines and ease tie-ups, the Ministry of Posts & Telecommunications (MPT) will take active steps toward large-scale transformation and expansion of microwave, fiber-optic and satellite long-haul communications networks.

In the area of microwave trunklines, China still has 3400 kilometers of 600-circuit electron-tube microwave lines dating from the late sixties and early seventies. This year, MPT will import from the U.S. secondhand equipment to modernize ten major communications trunklines.

In the area of east-west fiber-optic arteries, the Nanjing-Wuhan segment of the [2200-kilometer] Nanjing-Wuhan-Chongqing fiber-optic cable project [see early report in JPRS-CST-88-014, 25 Jul 88, p 159] is now under construction, and when it is completed, the first step will be to connect it up to the already-operational main microwave channel between Wuhan and Chongqing; a later step will be to complete the Wuhan-Chongqing segment of this fiber-optic cable. In the area of north-south fiber-optic arteries, plans are to use a Japanese loan in yen to build a Beijing-Shenyang-Changchun-Harbin fiber-optic cable [see JPRS-CST-88-020, 28 Sep 88, p 75], and to extend it

from Shenyang to Dalian. Also planned is a larger seacoast communications trunkline, running from Dalian to Yantai, Qingdao, Lianyungang, Shanghai, Ningbo, Hangzhou, Fuzhou, Xiamen, Shantou, Guangzhou, and finally to Hainan Island.

In the area of satellite communications, there are five completed satellite earth stations: Beijing, Guangzhou, Urumqi, Lhasa, and Hohhot. The four stations currently under construction are Qingdao, Chongqing, Chengdu, and Haikou. Planned are ten stations, including Shanghai, Kunming, Harbin, Shenyang, Fuzhou, Xiamen, Nanning, Wuhan, Xi'an, and Lanzhou. These stations will be merged into the domestic satellite communications network.

### **Microwave Power Tube Developed; Can Replace Export-Restricted Item**

40080233a Beijing DIANZI SHICHANG  
[ELECTRONICS MARKET] in Chinese 29 Jun 89 p 1

[Article by Yu Kui [0060 5525]: "Major Breakthrough in Area of Advanced Technology: Microwave Power Tube Developed in China"]

[Summary] The domestic development of a series of microwave power tubes, devices badly needed in China but ones which fall under foreign export restrictions, was announced on 4 June. Testing has shown that the high-frequency performance, the low-voltage operating characteristics, and the linear characteristics of the devices are all superior to those of similar foreign products; moreover, the manufacturing requirements are simpler

than those abroad. These tubes, critical items in microwave power amplifiers used in communications transceivers, microwave repeaters, and satellite communications equipment, have of necessity been imported in the past; in addition, critical military equipment needs have now fallen under a foreign embargo.

Professor Zhu Enjun [2612 1869 0971], chief specialist at the New Devices Laboratory of the Beijing University Institute of Microelectronics, has boldly reformed traditional theory; in the world's most authoritative report, the U.S. ELECTRONIC DEVICES BULLETIN, he laid forth his new concept. Assisted by a special fund set up by the State Commission of Science, Technology and Industry for National Defense, Professor Zhu and his lab group—in cooperation with researchers from Beijing Teachers' University, Institute 55 of the Ministry of Machine-Building & Electronics Industry, the Tianjin Semiconductor Devices Plant, and other units—have seen the concept materialize into real devices in a one-year breakthrough effort. To use the microwave tube found in low-voltage transceivers as an example, the U.S. firm Motorola Company's microwave amplifier has three-stage amplification, with a gain of only 5-10 times for each stage. Under identical conditions, the Chinese institute's corresponding product has a gain of 15-30 times per stage; its two-stage gain is thus equivalent to the U.S. product's three-stage gain.

In order to arrange as quickly as possible for commercialization of the product, the lab and other units have jointly set up Qixing [1142 2502] Electronics Ltd. in Shenzhen's Shekou; this firm will engage in integrated research and production of microwave amplifiers. Professor Zhu estimates that his new high-tech product can replace the imported version within one year and moreover can be marketed internationally.

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